VOCs EMISSION ON THE ALUMINUM SHEETS PAINTING LINE

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Abstract
During technological processes, pollutants are emitted into factories, pollute the working environment and transferred to the environment. Many pollutants emitted do not remain in one segment of the environment, but are transmitted from one medium to another and also affect the quality of air, water and soil. This paper describes the technological process of applying paints and coatings to aluminum rolled sheets and the procedures undertaken to remove and minimize organic volatile compounds - VOCs. Waste gas testing was conducted twice a year, in three individual samples, under the highest workload of stationary sources, over a period of 5 years. Based on the measured concentrations of total organic carbon, it was concluded that all values obtained were within the permitted limits prescribed by the Air Protection Act of the Republic of Serbia.

Key words: Aluminium rolled sheet, painting, pollutants emission, VOCs

Introduction

VOC is any organic compound having an initial boiling point equal to or less than 250°C at a standard pressure of 101.3 kPa. It can be natural or artificial. Emissions of highly volatile organic compounds - VOCs, have a short-term and / or long-term adverse effect on humans and the environment [1]. For this reason, the industry is taking a number of measures to reduce the emissions of these gases. The aluminum rolled sheets dyeing line consists of: degreasing of rolled sheets intended for dyeing, chemical preparation, application of dyes and dyes fired. The Bylaws of the Air Protection Act set the limit values for the emission of harmful and dangerous substances in the air at the place of the source of pollution, the manner and deadlines for measuring and recording data on the performed measurements of emissions. Permissible exposure limit (PEL) is the highest permissible level of pollutant in the air, established on the basis of scientific knowledge, in order to avoid, prevent or reduce harmful effects on human health and / or the environment. The conditions for performing the emission measurements (appropriate sampling points, safe access to sampling points, necessary facility data, etc.) are provided by the operator, and the measurements themselves are carried out by expert organizations authorized to measure emissions [2].
In the degreasing technological operation, the unpainted strip passes through 4 tubs cascaded, so that water from tub 4 is used to replenish tub 3 and from it when 2 and then 1 [3]. At the end of the degreasing process, there is a dryer that serves to completely dry the tape after exiting the squeeze roller. After drying, a defined layer of chemical to passivate the unpainted tape is applied to the horizontal device for chemical preparation in a closed system. After passivation, the tape is dried, cooled and switched to a technological dyeing operation [3]. A primer is applied to one or both surfaces of the tape by rollers with a rubberized coating in a paint application chamber, in the thickness of 5-15 μm. In the coating process, polyester, polyurethane, PVDF and epoxy paints, varnishes, solvents, and thinners are used for the coating process. After application, the primer is fired in furnaces (in four zones) at a

temperature of 216-241 °C [3]. Figure 1 shows a technological diagram of the process of dyeing aluminum sheets.

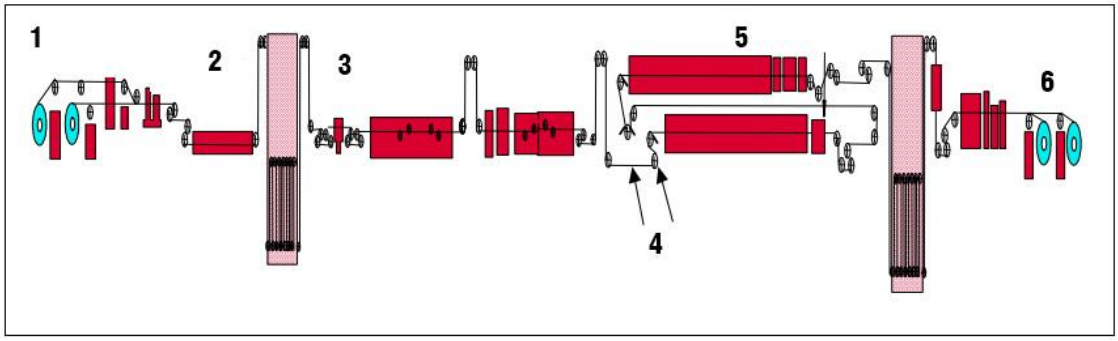

Figure 1. Technological scheme of dyeing aluminum rolled sheets
1 - sheet entry, 2 - degreasing, 3 - chemical preparation, 4 - dyeing chamber, 5 - firing furnaces, 6 - output

The firing temperature is achieved with the help of a natural gas burner. Part of the air used for the operation of the burner is supplied by a ventilation system from the chamber to apply a wet coating. The chamber air contains VOCs compounds that evaporate at ambient temperature as the paint rolls and cleans. Exhaust gases generated during the coating process are routed to the incinerator. The main function of incinerators is to control the process after combustion of waste gases and to reduce VOCs emissions. The temperatures at which incineration is carried out are between 590-1200 °C. Based on the data at a gas holding time of 0.75 seconds, 98% of the VOCs would be combusted and thus the VOC emission level would reach 20 mg / m^3, the incineration temperature should be 870 °C. According to the regulations in force in the Republic of Serbia, the limit value for the emission of VOCs into the atmosphere is 50 mg/Nm^3. By reducing the incineration temperature, the degree of VOCs conversion of the compound decreases exponentially [4].

Experimental

Measurement of VOCs emission was performed by measuring devices (GLOBUS, Italy) using prescribed and documented methods of measurement and standards - the continuous method of flame ionization detection (SRPS EN 12619: 2013 [5]). The basic goal of any sampling and measurement technique is to provide an air sample that is representative. Comparison of measured pollutant concentrations with emission limit values is a key element in any emission measurement. Accurate and reliable documented results are necessary to accurately determine measures to reduce the adverse environmental impact of the plant or broadcasters [2]. The results of the emission measurements, reduced to dry waste gas, standard conditions and reference oxygen content, are compared with the emission limit values. For comparison with the emission limit values, the measurement results expressed as mass concentrations of pollutants in the flue gas are calculated per unit volume of dry or wet flue gases, normal conditions (273.15 K and 101.3 kPa) and the oxygen reference fraction in the flue gas, unless otherwise specified [2].

Measurements were made twice a year (in the first half of the year - measurement I and in the second half of the year - measurement II), three samples were taken for each measurement.

Table 1. Overview of pollutant limit values [4]

Pollutant	Design value
VOC (organic compound expressed as total carbon)	<30 mg/Nm^3

Pollutants measured in waste gas from the dye line emitter were determined on the basis of the Decree on the list of industrial plants and activities controlling the emission of volatile organic compounds, the emission values of volatile organic compounds at a given solvent consumption and the total allowable emissions, as and emission reduction schemes (Annex 5, Item 7, Coating Solvent Consumption Coils> 25 t/year) [6]. Table 2 shows the results of periodic measurements on the emitter of the dye line from 2013 to 2018 at the Impol Seval plant in Sevojno.

Table 2. Results of periodic measurements of VOC emission at the emitter of the Dye Line [4]

Period of time measurements	Sample 1 (mg/Nm^3)	Sample 2 (mg/Nm^3)	Sample 3 (mg/Nm^3)	GVE [6] (mg/Nm^3)
I period 2013.	9 ± 0,45	11 ± 0,55	14 ± 0,70	50
II period 2013.	6 ± 0,30	10 ± 0,50	16 ± 0,80	
I period 2014.	3,50 ± 0,14	3,90 ± 0,16	4,10 ± 0,16	
II period 2014.	6,10 ± 0,30	6,90 ± 0,35	7,50 ± 0,38	
I period 2015.	1,76 ± 0,09	2,10 ± 0,11	2,60 ± 0,13	
II period 2015.	5,45 ± 0,27	6,10 ± 0,31	6,30 ± 0,32	
I period 2016.	21,5 ± 11,5	21,2 ± 11,5	20,1 ± 11,5	
II period 2016.	7,32 ± 0,37	7,08 ± 0,35	5,76 ± 0,29	
I period 2017.	7,52 ± 0,49	8,86 ± 0,57	7,15 ± 0,46	
II period 2017.	19,1 ± 1,2	10,5 ± 0,7	14,4 ± 0,9	
I period 2018.	38,0 ± 2,5	46,1 ± 3,0	43,6 ± 2,8	

Table 2 shows an increase in the measured values of VOCs emissions since during this period the beginning of the heating season and the increased combustion of furnaces, the operation of car engines and industrial plants contributes to the increase of the values of volatile organic compounds. The air quality assessment is done by the Environmental Protection Agency on the entire territory of Serbia and is done by analyzing the average annual values of pollutants. Along with the average annual values, the exceedances of the daily and hourly limit values of individual pollutants are monitored, and these results are good indicators of cleaner production.

The process of dyeing aluminum sheets carries out the process of cleaner production and with the aim of saving, reducing the environmental impact and fulfilling the legal obligations in the field of environmental protection. Cleaner production in production processes involves the more rational use of raw materials, water and energy, the replacement of hazardous raw materials by more environmentally friendly ones, and the reduction of emissions and toxicity of emissions and waste into water, air and soil. The emission values in the flue gases according to the above regulation for the consumption of solvents greater than 25t/year are 50 mg/Nm^3 and from the presented results it has not exceeded the permitted value in any measurement in the period of 5 years. It is observed that the concentrations in the last year of measurements are significantly higher than the previous measurements.

Conclusion

The Law on Air Protection ("Official Gazette of the RS" No. 36/2009 [7] and No. 10/2013 [8]) industrial pollutants in Serbia are obliged to report annually on emissions of harmful gases released into the environment and to pay certain environmental taxes accordingly. In particular, Article 45 of this Law defines the use of organic solvents. A legal entity and an entrepreneur using organic solvents in their production process is obliged to implement measures to reduce the emission value of volatile organic compounds below the prescribed values.

Based on the results of the test of the waste gases on the dyeing line for a period of 5 years, there was no exceeding of the prescribed emission limit value. The techniques used for the removal of volatile organic compounds are sufficient to purify the waste gases and avoid the pollution of atmospheric air at this stage of processing of aluminum and its alloys. Reducing the amount of pollutants released today is a basic form of air protection. The installation of filters and special exhaust and smoke purification plants at factory plants can produce good results. A special group of air protection measures are greening actions in the area where the air pollution occurs.

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